Research Report 1292

12

SUMMARY OF THE ARI-BENNING RESEARCH PROGRAM ON M16A1 RIFLE MARKSMANSHIP

Seward Smith
Army Research Institute

Arthur D. Osborne
Litton-Mellonics Systems Development Division

and

Thomas J. Thompson and John C. Morey
Army Research Institute

ARI FIELD UNIT AT FORT BENNING, GEORGIA

U. S. Army
Research Institute for the Behavioral and Social Sciences

June 1980

U. S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the

Deputy Chief of Staff for Personnel

JOSEPH ZEIDNER
Technical Director

L. NEALE COSBY
Colonel, IN
Commander

Research accomplished under contract
to the Department of the Army

Litton-Mellonics Systems Development Division

NOTICES

DISTRIBUTION: Primary distribution of this report has been made by ARI. Please address correspondence concerning distribution of reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, ATTN: PERI-TST, 5001 Eisenhower Avenue, Alexandria, Virginia 22333.

FINAL DISPOSITION: This report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Research Report 1292	2. GOVT ACCESSION NO.: AD-A109467
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: SUMMARY OF THE ARI-BENNING RESEARCH PROGRAM ON M16A1 RIFLE MARKSMANSHIP	5. TYPE OF REPORT & PERIOD COVERED: Research Report, 1976-1980
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Seward Smith, Arthur D. Osborne*, Thomas J. Thompson and John C. Morey	8. CONTRACT OR GRANT NUMBER(s): DAHC19-77-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS: *Litton Mellonics Systems Development Division, P.O. Box 2498, Fort Benning, GA 31905	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2Q263743A773, 2Q263731A773, 2Q263743A794
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, VA 22333	12. REPORT DATE: June 1980
	13. NUMBER OF PAGES: 32
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*: UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

M16A1 rifle, Rifle marksmanship training, marksmanship ranges, marksmanship targets, Down-range feedback, Knowledge of results, Zeroing, Training Effectiveness Analysis, Marksmanship problems, New marksmanship program, Adequacy of the M16A1 rifle

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report summarizes the major products of research on rifle marksmanship conducted by the Army Research Institute at Fort Benning, mostly between March 1978 and June 1980. It includes research designed to identify the problems existing in basic marksmanship training and training equipment (e.g., poor instruction, insufficient practice and inadequate knowledge of shooting results). Several experiments are reported that examined promising solutions to these problems. These solutions include simplified fundamentals, an

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

Item 20 (Cont'd)

improved zeroing target, better diagnostic check points, down-range feedback and other procedures to improve knowledge of results, improved transition to firing and steps to improve instructional quality.

Based upon the research findings, a new basic rifle marksmanship program was developed and tested. It was found to improve record fire (final exam) performance by 29 percent. This new program has been put into effect in the Infantry Training Brigade at Fort Benning and is soon to be adopted Army-wide.

The report also summarizes the main problems remaining to be resolved if fully adequate basic marksmanship training is to be realized. It concludes with information about the continuing research directed toward development of improved advanced individual and unit level training in marksmanship.

Research Report 1292

SUMMARY OF THE ARI-BENNING RESEARCH PROGRAM ON M16A1 RIFLE MARKSMANSHIP

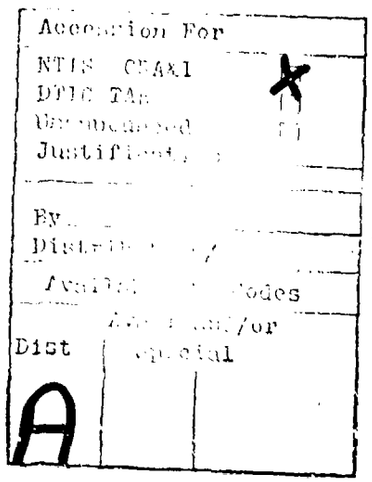
Seward Smith
Army Research Institute

Arthur D. Osborne
Litton-Mellonics Systems Development Division

and

Thomas J. Thompson and John C. Morey
Army Research Institute

ARI FIELD UNIT AT FORT BENNING, GEORGIA



Approved by:
E. Ralph Dusek, Director
PERSONNEL AND TRAINING
RESEARCH LABORATORY

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333

Office, Deputy Chief of Staff for Personnel
Department of the Army

June 1980

Army Project Numbers
2Q263743A773
2Q263731A773
2Q263743A794

Training Effectiveness Analysis
for M16A1 Rifle Marksmanship

ARI Research Reports and Technical Reports are intended for sponsors of R&D tasks and for other research and military agencies. Any findings ready for implementation at the time of publication are presented in the last part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

FOREWORD

The research program summarized here was performed by the Army Research Institute - Fort Benning Field Unit, in collaboration with the US Army Infantry School, Committee Group of Fort Jackson and the Army Marksmanship Unit at Fort Benning. Some parts of the research were carried out with the cooperation of the US Marine Corps and the Committee Group, the Infantry Training Brigade and the Army Infantry Board, all of Fort Benning. This report summarizes work to date on an ongoing program of research directed toward development of cost effective methods for individual and collective training in M16A1 rifle marksmanship. The overall program addresses M16A1 marksmanship at basic training, advanced individual training and unit training levels. It is concerned with all aspects of training inquiry from problem assessment, through instructional program improvement, to study of training aids and devices.

The experiments reported herein have been concerned with Basic Rifle Marksmanship (BRM) at the Basic Training level. The variables studied were chosen as promising candidate improvements for BRM. Other experiments have been and will be conducted to provide an additional empirical basis for training improvements. The overall goal of the research effort is development of an integrated family of programs to take the firer from BRM through unit level skills in a cost effective manner. This is a task often begun and never fully completed.

The research was coordinated with the United States Army Infantry School which is the proponent agency for M16A1 rifle marksmanship training program development.

ARI research in marksmanship training systems development is conducted as an in-house effort augmented by contracts with organizations selected as having unique capabilities for research in the area. The project was conducted as part of Army RDTE Project 2Q763743A773, FY 78 Work Program, 2Q263743A773, FY 79 and 2Q263743A794, FY 80. It was directly responsive to the requirements of FORSCOM, USAIS and TRADOC.

Joseph Zeidner

JOSEPH ZEIDNER
Technical Director

SUMMARY OF THE ARI-BENNING RESEARCH PROGRAM ON M16A1 RIFLE MARKSMANSHIP

BRIEF

Requirement:

In 1976 the U.S. Army began research intended to upgrade the training of M16A1 rifle marksmanship for entry level soldiers. Several experiments and field evaluations have been carried out by the U.S. Army Research Institute, Fort Benning Field Unit (ARI) since that time. The purpose of the current report is to summarize the various ARI ideas and products that characterize this overall research program to date so that there will be clearer understanding of the new marksmanship program that has been developed by ARI (for Army-wide adoption) based upon the findings of this research program. Another important purpose of the paper is to bring attention to those critical problem areas that remain unattended, even as the new training program is about to be fully implemented. A final purpose is to outline the work still remaining to be completed in order to develop an integrated set of instructional programs from basic rifle marksmanship (already completed) to advanced individual marksmanship training and unit marksmanship training (both in progress).

Procedure:

The research reported/summarized here consisted of three major field training experiments, a large scale field test of M16A1 weapon characteristics/capabilities and field observations/interviews at Army training centers and at the U.S. Marine Corps. The research was designed to determine what the problems were with U.S. Army basic rifle marksmanship training, to pilot test promising ideas for improvement and to field test the impact of the potential improvements.

Findings:

Early portions of the research revealed serious problems in existing Army marksmanship training (as of spring, 1978). The major problems found were: poor quality of instructors (often having to work with high ratios of trainee to instructor, when individual attention is needed), little opportunity for practice of necessary skills, and insufficient feedback of where bullets were landing so that correction of problems was difficult.

Through pilot testing a new zeroing target was developed as was a simple procedure to provide down-range feedback for bullet hits and misses.

Field experiments confirmed that use of these techniques resulted in significant improvements in record fire. Also developed were scaled silhouette targets for use at 25 meters (e.g., for teaching center of mass aiming) and simplified fundamentals of marksmanship. These, too, have been experimentally tested and found to result in improved shooting performance. It was experimentally determined that the typical M16A1 rifle could be expected to be capable of hitting all targets out to 300 meters but that typical ordnance checks might not identify a faulty rifle. Only a test firing by a skilled shooter could do so. Among the problems that remain unsolved by the new program are instructor quality and number and a need for firing facilities giving more detailed hit and miss feedback at range than is currently possible.

Utilization of findings:

Based upon these experiments and several other pilot studies a new program of instruction has been developed, refined and tested with over 8,000 troops in initial entry training. In June 1980 the Assistant Commandant of the Infantry School (as proponent) approved the program for adoption Army wide. The process of implementation is now under way.

SUMMARY OF THE ARI-BENNING RESEARCH PROGRAM ON M16A1 RIFLE MARKSMANSHIP

CONTENTS

CONTENTS (continued) Page

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Rifle marksmanship and its associated training and evaluation have had a long history of emphasis in the U.S. Army. At least four major improvement efforts, for example, have been conducted within the last 25 years (Dees, Magner and McClusky, 1971; Olmstead and Jacobs, 1969; McFann, Hammes and Taylor, 1955; Staff (HumRRO), 1959).

The most recent research, and the subject of this report, stems from rapidly growing costs of training and training equipment and from the Defense Department's greater emphasis on evaluating the products of training.

In 1976 the U.S. Army began conducting cost and training effectiveness analyses (CTEA) of several weapon systems. The intent has been to find training procedures and devices that produce maximized man/system performance at an affordable cost. An early example was the CTEA of the M16A1 rifle. In January 1976, Headquarters, Training and Doctrine Command (TRADOC) directed the U.S. Army Infantry Center (USAIC) to test and evaluate the then current basic rifle marksmanship (BRM) training and three candidate alternate programs which required various lesser amounts of ammunition and training time. Overall, the responsible agency was the TRADOC Systems Analysis Activity (TRASANA). The Fort Benning Unit of the Army Research Institute (ARI) had responsibility for portions of that test (Hicks and Tierney, 1978; Tierney and Cartner, 1978; Tierney, Cartner and Thompson, 1979) and has since pursued a systematic research program in rifle marksmanship.

A large number of pilot studies and several field experiments have been carried out in this continuing research program. These have been documented in various separate reports. There is a major logic and pattern tying all these efforts together that may not be evident from reading any single report. Thus, a major purpose of this current report is to summarize and integrate the entire research program and its findings to date. There are major implications involved for: training development; marksmanship ranges, target equipment and training aids; instructor training; and resource policy. This report should, therefore, be of direct interest to: training developers, training managers, trainers, training equipment developers and those involved in policy and decisions related to all of these.

The 1976 BRM Test

The 1976 BRM Test (the CTEA) was conducted at Fort Jackson, South Carolina. The purpose was to determine if cost/time savings could be realized by trying the alternate programs, shown in Table 1, in comparison with the Army Subject Schedule (ASUBJSCD 23-72), the marksmanship program

Table 1

Comparison of Programs of Instruction Evaluated in the 1976 Basic Rifle Marksmanship Test

Total Hours in Rounds

Program	Hours	Rounds
ASUBJSCD 23-72 (Baseline)	77	720
Fort Jackson	62	513
Fort Dix	49	262
Fort Benning	35	334

Subjects Covered and Hours of Instruction

Subject	ASUBJSCD 23-72	Fort Benning
Mechanical Training	4	4
Marksmanship Fundamentals and Battle Sight Zero	22	8
Field Fire	30	12
Record Fire	10	5
Automatic Fire	3	3
Night Fire	8	3

in use at the time. If a shorter, less costly program would produce the same result as the ASUBJSCD training, the savings could be applied to critical training needs elsewhere. The four programs resulted in relatively similar final performance. TRASANA concluded that the shortest program of instruction (POI), the Fort Benning POI, resulted in final performance that was acceptably close to the baseline program (though it was statistically significantly poorer) and could therefore be substituted for it (TRASANA, 1977). This substitution was accomplished in April 1977 with the publication by the U.S. Army Infantry School (USAIS) of a 37 hour, 334 round BRM POI (USAIS, 1977) which added two hours of preliminary marksmanship training to the test POI. The preface to that document acknowledged that this was only an interim measure. It said:

> This new training program is a product of the Infantry Center's cost and training effectiveness analysis for the M16A1 rifle; however, it is not a final product. The long term efforts are directed toward the development of a totally new concept to defeat the modern battlefield threat. As new technological and training progressions become available, this program of instruction will be revised and subsequent training techniques will be forwarded for integration into this program.

In retrospect two problems were evident in the BRM test. The first was the assumption that the ASUBJSCD 23-72 program resulted in acceptable BRM performance, but was just too costly. In fact, the assumption of adequate performance was probably unjustified. During the test that program produced only about 55 percent target hits in spite of nearly half of the target exposures occurring 50, 100 or 150 meters from the firer. Only about 27 percent of the targets at 300 meters (the greatest distance) were hit.

Examination of Table 1 reveals another curious fact. The major cuts registered by the Fort Benning curriculum were in marksmanship fundamentals, zeroing and field firing--all areas which should be affording skill practice and therefore skill improvements. If repeated hours and rounds spent on these activities in the ASUBJSCD program were not leading to more firing skill, one would need to conclude either that skills were already maximized or that something was wrong with the training. In view of the fact that several marksmanship programs (e.g., Great Britain, Federal Republic of Germany) require 70 percent hits on comparable qualification ranges as a <u>minimum</u> standard, 55 percent hits for the Army's program clearly did not represent maximized skill. It appeared wise, therefore, to conduct a careful analysis to determine what was wrong. This became an early high priority ARI task.

ARI-BENNING ACTIVITIES

The ARI-Benning research in marksmanship has been conducted under the sponsorship of the U.S. Army Infantry School (Directorate of Training Developments) and Forces Command (FORSCOM) and has been directly responsive to Human Research Needs (HRNs) prepared by those agencies.[1]

Based upon an evaluation of findings from the 1976 BRM test and growing concern that BRM training is not sending qualified marksmen to combat ready units, the goal of the project is to examine marksmanship training at basic, advanced and unit levels and to develop and test an integrated set of effective marksmanship training programs geared to combat marksmanship needs (e.g., to meet the threat).

Early ARI Marksmanship Research Activity

At the start of the research the project was planned to answer several "threat" oriented questions as shown in Table 2. Several reports were therefore prepared by ARI and by Litton-Mellonics (the ARI-Benning resident contractor). They deal with definition of the rifle defeatable threat (Klein and Tierney, 1978), past marksmanship research (Smillie and Chitwood, 1977) and current training procedures and other possible training approaches (Maxey and George, 1977; Maxey and Swezey, 1977).

It appeared obvious that BRM training was not preparing soldiers to meet the rifle defeatable threat--namely fleeting, often moving personnel targets from 300 meters away and closer. What was not so clear was what was wrong. The project staff began to search for that answer by undergoing BRM training as participants and observers.

BRM Problem Diagnosis

Four members of the ARI-Benning/Litton-Mellonics staff took part in BRM training at Fort Jackson, South Carolina, in March 1978. By then the

---

[1] The research has been or is being performed in response to HRNs: 77-184 and 78-104, Training Effectiveness Analysis for Infantry Systems (USAIS); 79-216, Improvement of Rifle Marksmanship (FORSCOM); 80-60, Infantry Systems Training Effectiveness Development (USAIS); 80-110, Develop Plan for Assessing Weaponeer Training Effectiveness in TOE Units (USAIS); 80-111, Research Directed at the Development of Methodology for Evaluating Retention of Skills in Gunner Assessments (USAIS); and 80-115, Research on Target Engagement Training for Individual and Crew Weapon Systems (USAIS).

Table 2

The Marksmanship Training Effectiveness
Analysis Research Task

- What is the combat threat to be met?
- What performances are required?
- How are performances to be measured?
- Does existing training meet the threat?

  If no, then problem diagnosis and remediation required in possible areas of:

  Performance feedback
  Performance measurement
  Training content
  Training aids/devices/ranges
  Quality of instruction/instructors
  Training management
  Policy decisions

Infantry School's 37 hour POI was in use. During that week of training it became clear what some of the major problems were.

Performance Feedback. Probably the most serious problem with the BRM program was that it contained very little detailed feedback that could be used to sharpen marksmanship skill. At 25 meters, fundamentals were compressed into 10 hours of formal training, during which time the trainee might fire as few as 27 shots. This was too little time and insufficient practice to attain the fundamentals of steady position, proper sighting, trigger control and breath control--let alone accurate zeroing of the rifle. These 27 shots at least gave performance feedback because the trainee walked down range to examine the 25 meter target after firing each three shots. From this point on, however, killable popup silhouette targets that fall when struck by a bullet were used for all remaining shooting (e.g., field firing, record firing). Unfortunately, the trainee has no way to determine where on the silhouette the hit is located and, in the event of a miss, may receive no cue at all where the bullet went.

The killable target was designed in the 1950s to teach transition to field firing at fleeting, indistinct, combat-like targets once the

trainee had fully mastered the fundamentals of shooting. It was never intended to be nor is it at all suitable for providing the detailed shot by shot feedback necessary for diagnosing problems, correcting a faulty zero or gradually refining and sharpening a beginner's shooting ability.

It is a universally accepted principle of learning that there must be relevant, detailed and timely knowledge of performance results if successful learning is to take place. We found that the BRM program we participated in at Fort Jackson lacked most of that necessary feedback.

Instruction and Other Problems. Several other problems were found. Much of the instruction appeared to be hurried with little opportunity for practice or later review. Concurrent training, conducted for some trainees while the others were shooting, often did not reinforce what was happening on the firing line. There were few performance measures taken that could be used to check progress or that could be used to detect persons with problems. It was noted that the standard zeroing target was confusing to use and zeroing in general was difficult to learn. It appeared that many trainees missed significant portions of the instruction and, because of the compressed schedule, had no opportunity to make up what was missed.

Training content too appeared to be a problem. Nothing was taught about the effects on the bullet of wind and gravity. Much of the traditional information of the past seemed to have been lost or reduced to "the eight steady hold factors," combining elements of "firing position" with principles such as "trigger squeeze" and "breathing" and which few persons seem to have mastered.

The most serious instructional problem seemed to be the general lack of knowledge or skill in marksmanship training and diagnosis on the part of the drill sergeants (who comprised the majority of the instructor pool). Very likely they had come through a similar thin, non-instructional, non-feedback marksmanship program themselves. They probably had not seen firsthand the down-range effects on bullets and had received little, if any, instruction or practice in how to teach BRM or in problem diagnosis and remediation. Due to budget constraints the Army has also greatly reduced the number of BRM teachers available so that it is not uncommon to see one instructor responsible for 10 or even 20 trainees at a time on the firing line. This of course results in virtually no opportunity for individual attention when trainees most need it.

By the end of our visit at Fort Jackson as BRM training participants it was clear that there were several ways that the training could and should be substantially improved.

Examination of BRM at Other Training Centers. Following participation in BRM training at Fort Jackson the staff made visits to Fort Dix, Fort Knox and Fort Leonard Wood to study their BRM training programs.

These four installations (including Fort Jackson) received the majority of trainee throughput for 1978 (approximately 70 percent) and so, for BRM purposes, these training programs had the greatest overall influence on the BRM skills and abilities of Army basic training graduates.

There were two purposes of the trips: first, to determine whether the Fort Jackson findings were typical or atypical and, second, to look for any innovations or training practices that could be shared to improve overall training. The results of these visits are contained in a report prepared by Litton-Mellonics (Maxey and Dempster, 1978). The training at the other training centers was found to be highly similar to that at Fort Jackson with few different or innovative ideas being utilized. The authors concluded that BRM could be strengthened by: improved instruction and instructors, increased use of diagnostic and remediative activities, better measurement/evaluation during BRM and overall better quality control of the entire BRM training process.

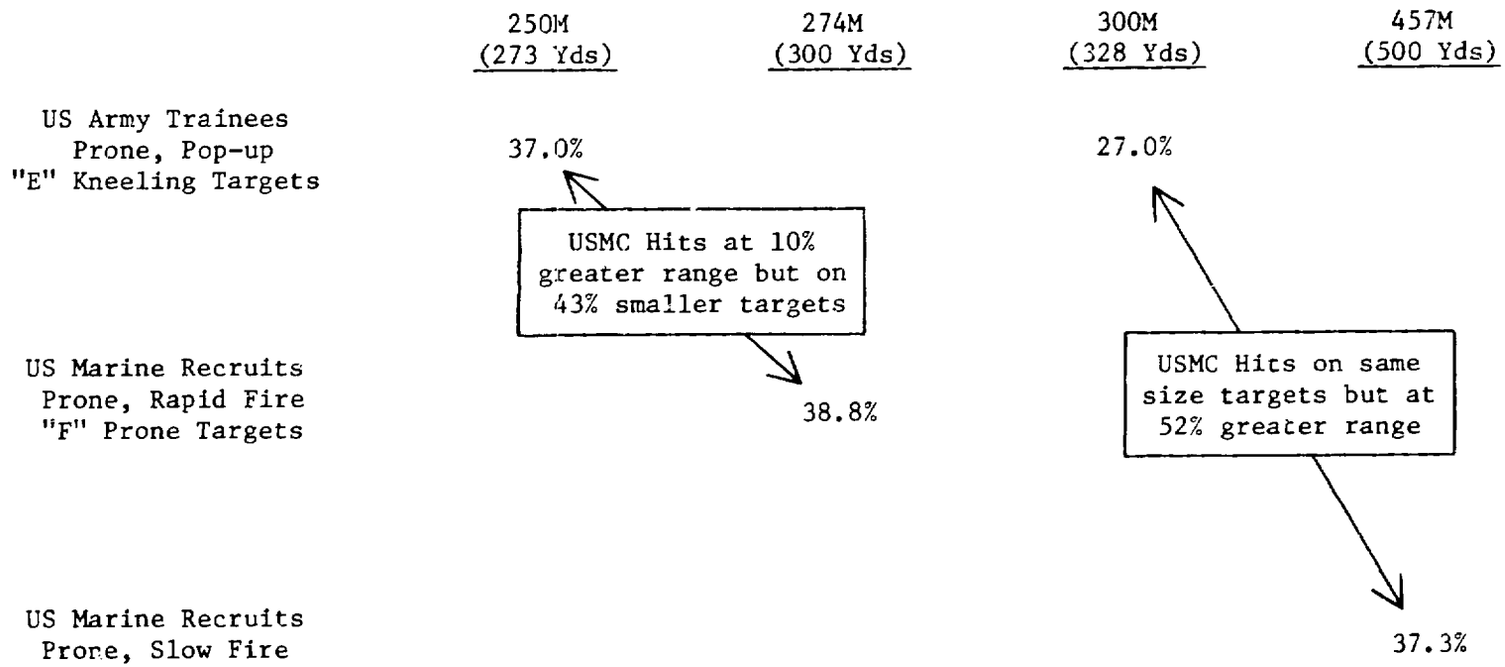
Marine Corps Rifle Training. Another trip was made in September 1978 to the U.S. Marine Corps (USMC) Recruit Training Depot at Parris Island, South Carolina. The research staff spent a week observing training and discussing training philosophy. Several major differences characterized the USMC program. Theirs was a two week long program (89 hours) involving a week of rigorous and detailed training in fundamentals prior to any live firing. During firing week the USMC uses known distance (KD) ranges with men downrange raising, lowering and scoring the targets and placing spotters in bullet holes to provide shot by shot feedback to the firer. The firing line is placed at 200, 300 and 500 yards (or meters in the case of San Diego) from the targets.

The Marines utilize dedicated, highly trained instructors. A primary marksmanship instructor takes responsibility for the training of each platoon for the entire two weeks and he has several coaches working for him during firing week who assist only two recruits at a time on the firing line. A great deal of individualized instruction is thus possible.

Our observations were that the typical Marine recruit is very knowledgeable about his rifle and the task of firing it. Table 3 provides information comparing performance achieved by Marine recruits taught under this program and Army trainees taught using the Fort Benning POI from the 1976 BRM test. Although the silhouette targets are not strictly comparable to the Army's field fire silhouette targets they are very similar and the shooting results show a dramatic difference. Army trainees fire at a kneeling silhouette (E type) out to 300 meters. They hit the 300 meter target about 27 percent of the time on the average. The Marine recruit only fires at that type of target at 500 yards (457 meters) but they hit it 37.3 percent of the time, even though their target is located at 52 percent greater range. In short, the USMC program produces considerably higher level shooting skill than does the current Army POI.

Table 3

Percentage of Silhouette (or in the Black) Hits During Qualification
by US Army Trainees[1] and US Marine Corps Recruits[2]



[1] Army N= 447, 1976 BRM Test

[2] USMC N= 89, randomly selected from 1977-1978 records

This finding does not necessarily suggest returning to KD firing or copying the USMC program, but it does clearly point up the apparent benefit of quality and/or number of instructors and the value to skill acquisition of meaningful knowledge of results.

Summary Evaluation of Army BRM Program Problems

Upon completion of the above participation and observations several generalizations emerged relating to the U.S. Army trainees, the instructors, the training ranges/targets and the rifle. These are summarized in Table 4. In general we found that Army trainees possessed little fundamental marksmanship knowledge and skill. One major cause appeared to be insufficient numbers of instructors, many of whom were inadequately qualified for their responsibilities. A second cause was trainees' difficulty obtaining an adequate weapon zero. A third was trainees' receiving totally inadequate knowledge of where their shots were going in field firing situations. Finally, it appeared that the weapon itself might be responsible for difficulty some trainees were experiencing. These various observations led to several pilot studies and field tests to answer questions posed and to test various ways to improve marksmanship training.

BRM EXPERIMENTS

ARI-Benning and Litton-Mellonics entered into partnership in research activity with the U.S. Army Marksmanship Unit, the Infantry School's Directorate of Training Development at Fort Benning and with the Committee Group at Fort Jackson, South Carolina. We immediately began pilot testing at Fort Benning of promising problem-corrective ideas that had been generated by our earlier examinations. As techniques were perfected they were evaluated in field experiments, usually with basic trainees undergoing BRM training at Fort Jackson.

Feedback and Instructor Quality and Quantity

The first major experiment was conducted at Fort Benning with the U.S. Army Marksmanship Unit (AMU) during September 1978. It examined annual M16A1 rifle requalification of 82d Airborne soldiers. Three experimental groups were tested. The first (N=89) went through one day of standard requalification with little instruction and little feedback. A second group (N=97) took part in a two day program with AMU instructors performing the training. There was a major increase in the quantity and the quality of instruction provided compared with usual annual requalification. The third group (N=88) was in a three day program that included the AMU instruction (as above) and a day on a KD range, shooting with

Table 4

Summary of Observations about the Army Basic Rifle Marksmanship Program upon Completion of the Problem Identification Phase of ARI Research

TRAINEES

Limited ability to maintain and operate rifle.

Limited knowledge of shooting fundamentals.

Little knowledge of zeroing process.

Poor zero achieved by many.

Limited knowledge of effects of wind and gravity.

INSTRUCTORS

Too few competent instructors.

Limited BRM knowledge.

Limited diagnostic skills.

Unable to conduct effective remediation.

RANGES, TARGETS AND TRAINING AIDS

Difficulty using zeroing targets.

No feedback on quality of pop-up target hits.

No feedback on pop-up target misses.

WEAPONS

Insufficient quality checks.

Hard trigger pull for some rifles.

Poor grouping ability of some rifles.

accurate down-range feedback. Groups 1-3 averaged 23, 25 and 28 hits (of 40) respectively on record fire. The third group's significant 22 percent increase ($p<.001$) over the standard condition indicated the value of better qualified instructors and/or shooting performance feedback. A detailed ARI report of this research is available which also describes comparable improvements in pistol qualification (Evans, Thompson and Smith, 1980).

Zeroing and Down-range Feedback

Two serious problems observed at Fort Jackson while undergoing BRM training were: trainees did not understand the rifle zeroing process and there was too little feedback available about shots fired at distant targets.

Figure 1 shows the Army's standard zeroing target used at 25 meters to obtain a battle sight zero. The purpose of zeroing is to adjust the

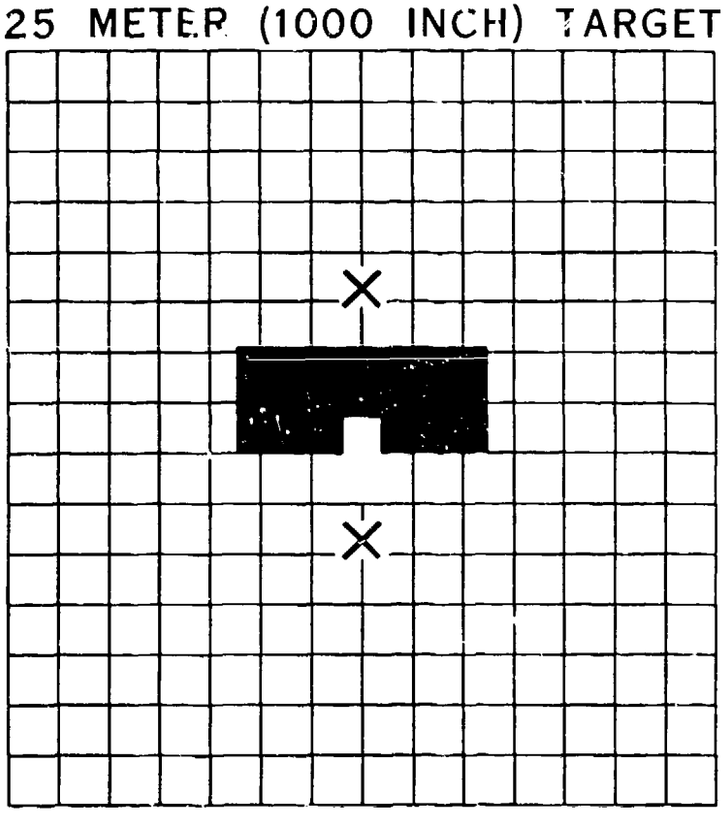


Figure 1. The U.S. Army standard M16A1 and M14 rifle zeroing target.

sights so that bullets will strike the target exactly where the sights are lined up for the chosen battle sight zero range (250 meters for the M16A1 rifle). Due to trajectory M16A1 rifle bullets should strike the lower X on this 25 meter target. The trainee has to move his sights two clicks for each block his shot group lands away from the X, plus interpolating if the shot group falls between squares. No instructions are printed on the target to tell which sight to move or in which direction to obtain weapon zero.

ARI developed a new zeroing target to clarify and simplify the zeroing process (see Figure 2). After locating the shot group center the trainee can look to the target margins to see how many clicks to move which sight in which direction on order to shift the next shot group to the desired spot. The target also furnishes cues about shooting at more distant targets. If the trainee can keep all bullets within the circle of this 25 meter target, he is likely to hit all targets out to 300 meters in later field firing. If he cannot, the target identifies the trainee as one who needs remedial assistance.

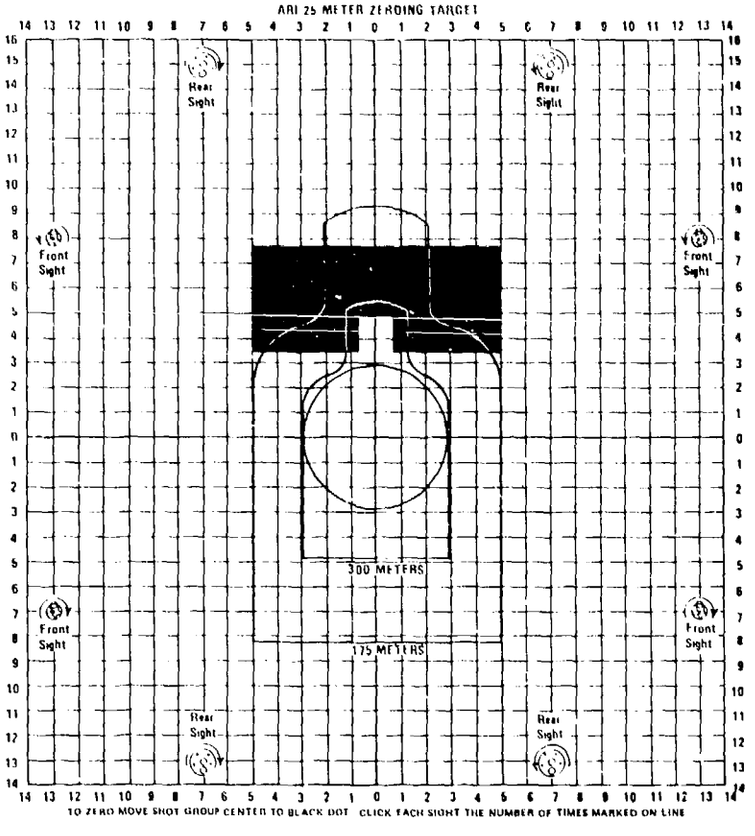


Figure 2. ARI-developed zeroing target for the M16A1 rifle.

For many years the Army taught marksmanship on KD ranges (just as the Marines do today), but in the late 1950s most of these ranges were abandoned in favor of pop-up target field fire ranges. It would be costly to rebuild those KD ranges so for test purposes ARI designed a down-range feedback process involving placing field fire targets (E and F silhouettes) against background paper on frames. These target frames were installed on an easily modified standard field fire range using the preexisting 75 and 175 meter target locations. Details of the range are shown in Figures 3 and 4. In use the trainee fires 3-round groups at the two targets in his lane and walks down range to see and mark where his bullets landed--whether hits or misses. From the markers prior shot group locations can thus be seen from the firing line and instructors can determine who among the trainees need instructional aid.

To test the adequacy of the new zeroing target and the down-range feedback procedure, a second experiment was conducted at Fort Jackson, South Carolina, during October and November, 1978. A total of 2,124 basic trainees took part in the experiment using an earlier form of the new rifle zeroing target and a period of added instruction during which the student fired at the 75 and 175 meter down-range feedback targets and then walked down range to see the results.

Four training conditions were compared. One group underwent standard training (and obtained 22.7 record fire hits). A second group used the new zeroing target in otherwise standard training (23.7 hits). A third group received down-range feedback training added to standard training (24.5 hits). A final group was given both the new target and down-range feedback (25.5 hits). The results showed a significant ($p<.005$) increase in record fire performance when the new zeroing target was used, a significant increase ($p<.001$) when down-range feedback was added and a yet greater increase ($p<.001$) when both were added to the training. It was concluded that the new zeroing target and down-range performance feedback would become parts of the projected new training. Details of this experiment are given in another ARI report (Smith, Thompson, Evans, Osborne, Maxey and Morey, 1980).

Tests of the Adequacy of the M16A1 Rifle

In the course of our research and observations we became concerned about the accuracy of published information about the M16A1 rifle (e.g., accuracy, trajectory) and about several training procedures using the rifle. We needed to know more about what the rifle could do and what problems there were with it. We wanted experimental evidence under controlled conditions, not anecdotal opinions. We therefore set up a variety of pilot tests which were performed with the cooperation and excellent test facilities of the U.S. Army Marksmanship Unit at Fort Benning. A comprehensive ARI report of the findings of this diverse research effort is available (Osborne, Morey and Smith, 1980).

Figure 3. The ARI down-range feedback exercise showing the smaller 75 meter target (A type) and the larger 175 meter target (E type) as seen from the firing line.

Figure [illegible] .22 long-range rimfire bullseye target showing construction and the use of spotters to call in shot group location and problem diagnosis.

Sixty weapons were drawn at random from weapons pools at Fort Benning. All 60 rifles were used for some testing but a smaller sample spanning the best to the worst shooting quality was used for other tests. Several findings are noteworthy.

1. The average M16A1 rifle available to trainees is capable of firing shot groups that easily fit within the four centimeter circle of the 25 meter zeroing target (2.11 cm. bench rest average, 3.03 cm. shooter average) and hence could be expected to hit all targets out to 300 meters.

2. The available serviceability checks will eliminate a malfunctioning rifle but will not detect a poorly shooting weapon. If a trainee is shooting poorly it could be the fault of his weapon. Only a test firing by a competent marksman can rule out the weapon as the problem.

3. Trigger pull ranged from 5.5 to 10.5 pounds (median 7.5 pounds). This is a quite heavy trigger pull but with experienced shooters shot group size didn't increase with greater pull weight. With inexperienced shooters there might be a problem with M16A1 rifles having greater than average trigger pulls.

4. Our tests confirmed that the M16A1 rifle trajectory on the average is as shown in Figure 5 and that the 25 meter zeroing procedure results in an acceptable 250 meter battle sight zero.

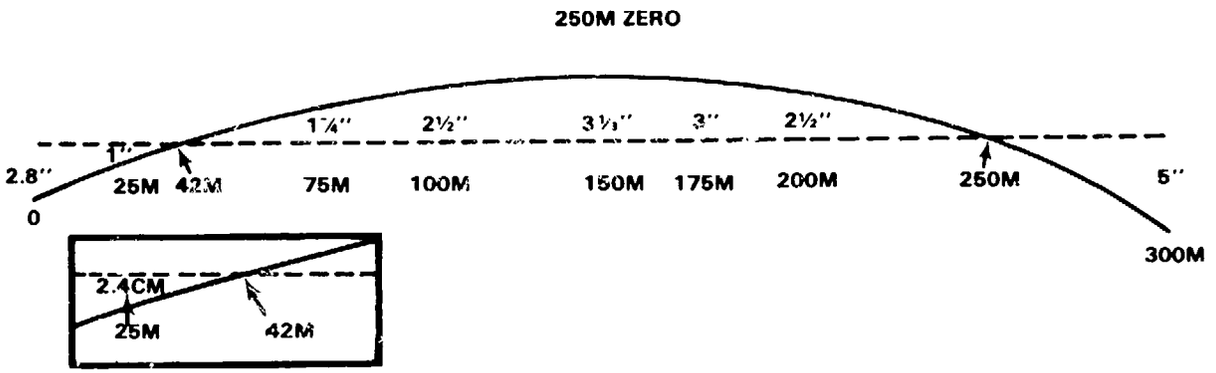


Figure 5. Trajectory of the M16A1 rifle when zeroed for 250 meters. Note that the bullet path crosses line of sight at 42 meters and 250 meters and will strike 2.4 centimeters low on targets placed at 25 meters.

5. The barrel of the M16A1 is easily distorted when using the hasty sling or the bipod compared with hand held firings. Use of the sling causes bullets to strike very low while the bipod causes very high shots. In fact at 300 meters the difference in bullet strike between these barrel bend sources can be as much as two to four feet.

6. With the M16A1 standard sights we found that failure to center the top of the front sight in the rear sight aperture was not likely to cause a hit error of greater than 6 inches at 300 meters.

Use of the Long Range Sight for 25 Meter Silhouette Firing

The long range sight on the M16A1 rifle shifts the battle sight zero of the weapon from 250 meters to 375 meters. In the process it moves the trajectory upward so that the bullet crosses line of sight at almost exactly 25 meters (see Figure 6). Thus, using the long range sight and engaging targets at 25 meters we found that the shooter will hit almost exactly where he is aiming. This led us to develop a 25 meter silhouette target suitable for zeroing using a center of mass aiming technique (see Figure 7). We also developed scaled silhouette targets for use at 25 meters (with the long range sight) that portray field fire targets the trainee will engage later in the BRM program (see Figure 8). The student can show that he understands center of mass aiming and can learn to hit these scaled targets as a transitional step before beginning field firing. Here he receives feedback about exact location of either hits or misses. In field firing against the popup killable targets far less feedback is given. Hence, using the scaled silhouette targets persons with problems can be identified and given remedial assistance before progressing to field firing.

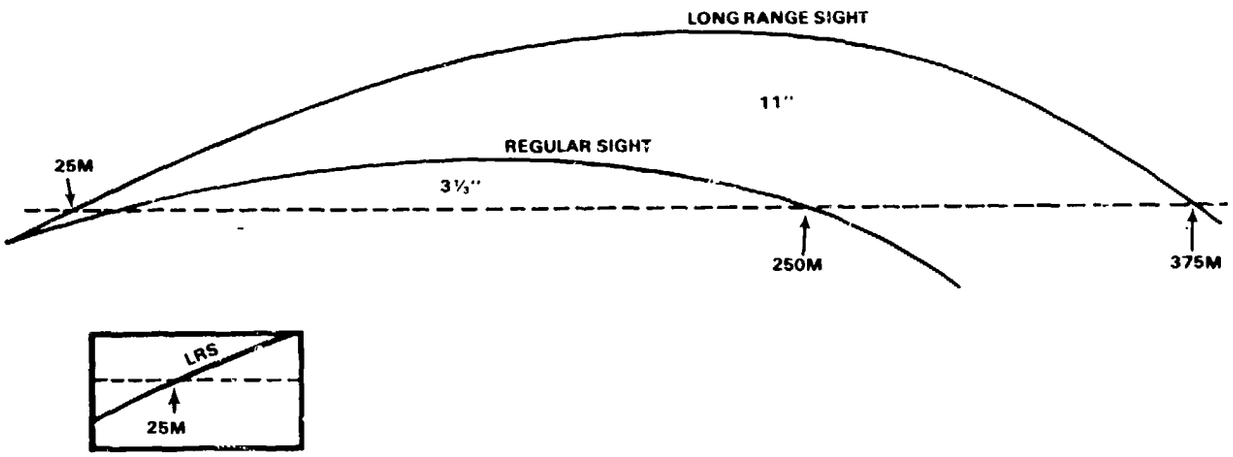


Figure 6. Trajectory of the bullet when using the M16A1 rifle long range sight after zeroing for 250 meters with the regular sight. Note that with the long range sight the bullet crosses line of sight at almost exactly 25 meters. Therefore, for targets placed at 25 meters point of aim and point of impact coincide.

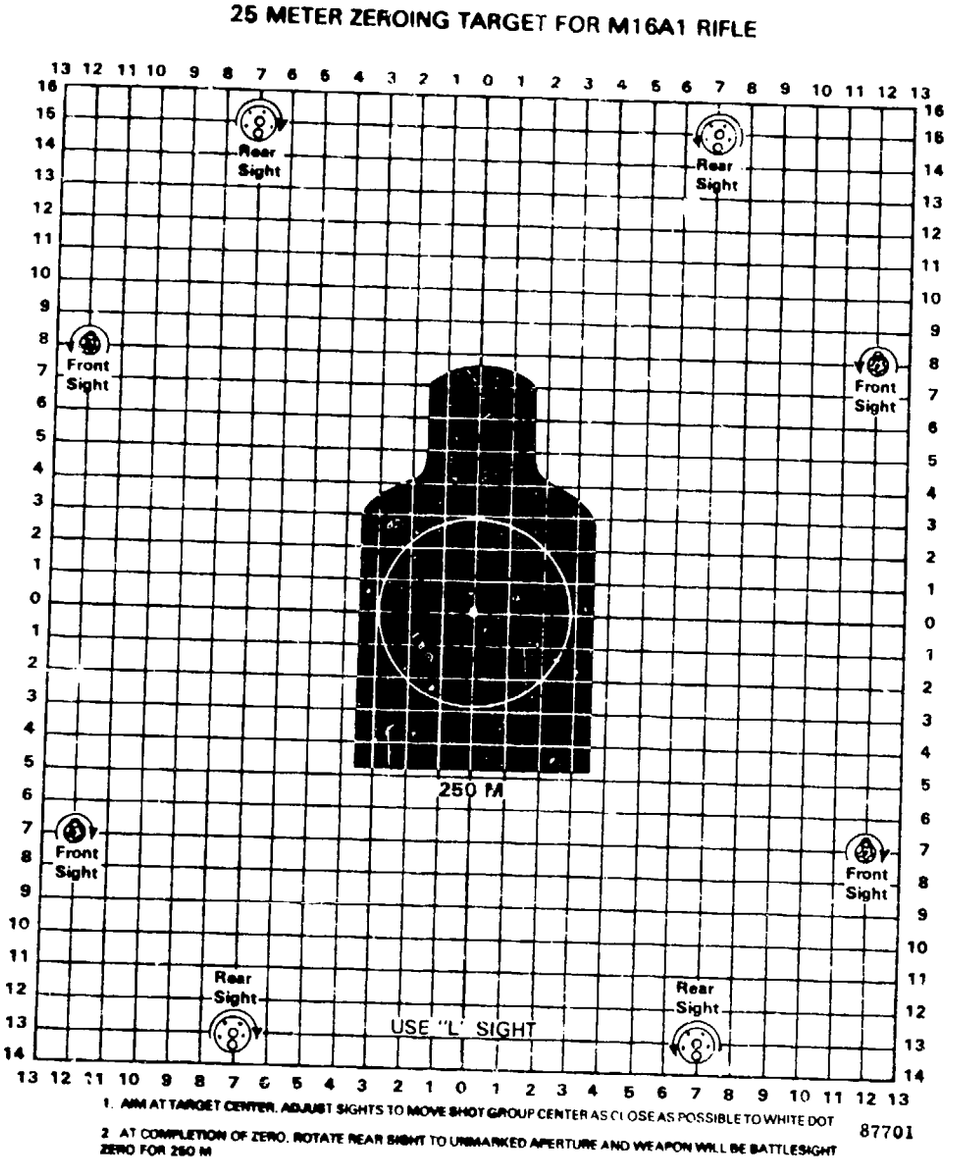


Figure 7. ARI-developed M16A1 rifle zeroing target for use with the long range sight so that point of aim equals point of impact at 25 meters.

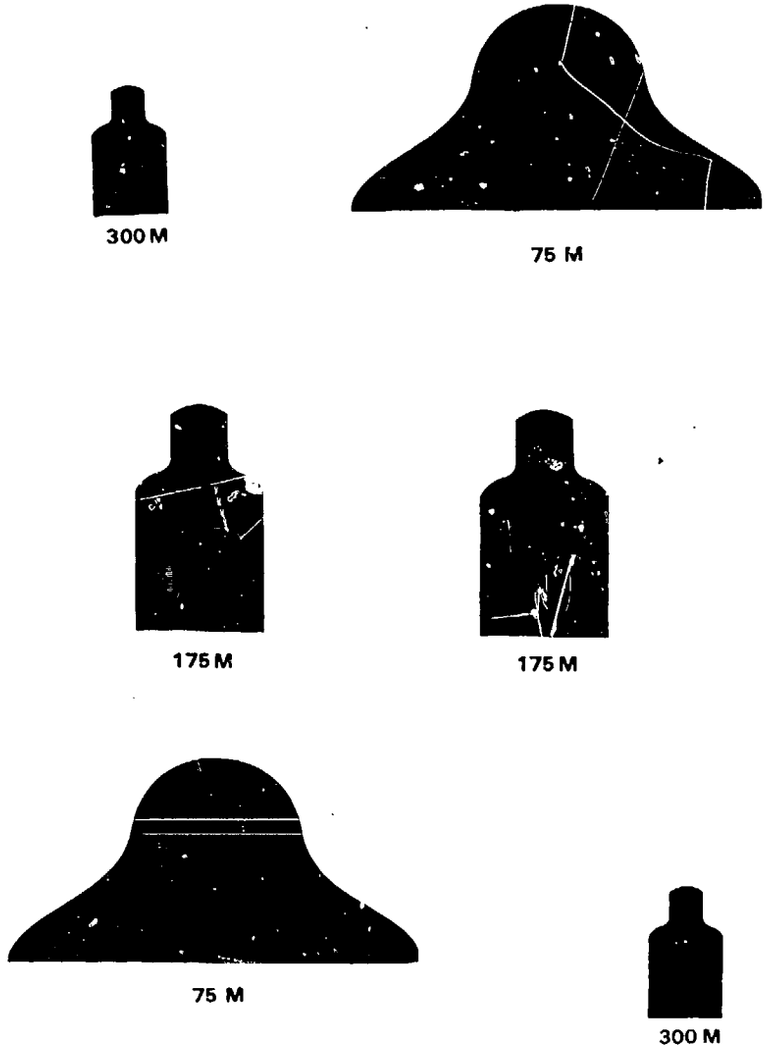


Figure 8. Scaled silhouette targets for use at 25 meters (shown reduced). Trainees use their long range sight so that point of aim equals point of impact. The 25 meter target is used as a transition prior to beginning field firing at targets at these actual ranges.

Test of Candidate New Basic Rifle Marksmanship Programs

The most recent major experiment tested the most promising combined programs for basic marksmanship training that had emerged from our previous research. It too was conducted at Fort Jackson, South Carolina. Data collection involved 1,151 male and female trainees from April through May 1979. Major features included were: the ARI zeroing target, scaled silhouette target transitional exercises, down-range feedback by walking down range to examine targets and, in some cases, extra instructors. The new programs also focused on the four fundamentals of firing (steady position, proper sighting, breath control and correct trigger squeeze), various means to diagnose shooters with problems, a logical skill acquisition progression and every possible way to provide shooting performance feedback.

We again used a baseline control consisting of students given the standard marksmanship training. Three new programs were designed. All three used the new zeroing target and silhouette target exercises. Varied were number of instructors (standard vs. augmented staff) and use of the downrange feedback exercise vs. use of additional silhouette firing at 25 meters.

The results of the experiment are covered in detail elsewhere (Thompson, Smith, Morey and Osborne, 1980). In general, the group receiving all improvements (an average of 26.5 record fire hits) outperformed the control condition (20.5 hits) by 29 percent ($p<.001$). Those who missed some training were poorer (usually by 3 to 4 hits) than those who were present for all instruction ($p<.001$). In this experiment, as in previous ones, men scored higher than women ($p<.001$) by 1.8 to 2.6 hits depending upon group assignment. The use of more instructors did not result in significantly better performance. One reason for this result is that some instructors are probably not properly qualified to instruct.

The experiment showed that we had found means to effect a substantial increase in the record fire performance of trainees, even with limited program resources.

NEW ARMY RIFLE MARKSMANSHIP PROGRAM

Based upon these experiments and several other pilot studies a new program of instruction has been developed, refined and tested with over 8,000 troops in initial entry training at the Infantry Training Brigade, Fort Benning, Georgia. In June 1980 the Assistant Commandant of the Infantry School (as proponent) approved the program for adoption Army wide. The process of implementation is now under way.

Full details of the program are contained in another document (USAIS, M16A1 Rifle Marksmanship Training, 1980). In summary, however, the program emphasizes five major points:

1. It stresses simplified fundamentals before moving on to field firing exercises.

2. It contains several diagnostic check points so that early problem detection and correction can occur.

3. It uses a natural progression from fundamentals through to rapid engagement of targets in combat-like setting with each exercise serving as a building block for those that follow.

4. It places major emphasis on feedback so students are given as much knowledge of their shooting performance as present technology and expense will permit. This is both for the poor shooter who needs help in correction of his mistakes and for the good shooter to help him sharpen his skills.

5. Finally, the program is designed to aid the instructor to be a more adequate teacher. As an aid to this process an instructor's guide has been prepared and is currently being field tested (USAIS, Basic Rifle Marksmanship Instructor's Guide, 1980).

Table 5 shows the contents, hours and rounds of the new marksmanship program contrasted with the current marksmanship program (ASUBJSCD).

UNRESOLVED MATTERS

It was stated earlier that the fundamental problems with current Army marksmanship were: inadequate quantity and quality of the instructor corps, insufficient shooting performance feedback to correct mistakes or sharpen skill, and inadequate time to practice and acquire skill. Attempts have been made in the development of the new marksmanship program to deal with these matters but most of the changes have had to be largely stop-gap. Much more could be accomplished by addressing the following points.

Quantity and Quality of Instruction

It will require policy decisions at the highest levels to correct the problems with the instructor corps. Even the new program in operation at Fort Benning still has to be taught with ratios of student to instructor on the firing line of 10 or 20 to 1, not because the problem is not recognized but because additional personnel are not available. Little instruction is possible under such circumstances. Marksmanship instructors are not specialists and are in fact, rarely given any special training before assuming their instructional duties.

Table 5

Comparison of the Current Basic Rifle Marksmanship Training Program and the New M16A1 Rifle Marksmanship Training Program

CURRENT BASIC RIFLE MARKSMANSHIP TRAINING PROGRAM				NEW MARKSMANSHIP TRAINING PROGRAM			
PERIOD	SUBJECT	HOURS	ROUNDS	PERIOD	SUBJECT	HOURS	ROUNDS
1	Orientation and Mechanical Training	4	0	1	Introduction and Mechanical Training	4	0
2	Preparatory Marksmanship Training	3	9	2	Fundamentals of Shooting (Dry Fire)	4	0
3	Preparatory Marksmanship Training	3	9	3	Fundamentals of Shooting (Live Fire)	4	9
4	Twenty-Five Meter Firing	4	24	4	Practice Firing (Zero)	8	21
				5	Practice Firing (25 M Silhouette)	2	18
				6	Downrange Feedback (75 M and 175 M)	8	30
5	Introduction to Field Firing	4	42	7	Field Fire and Target Detection (Single Targets)	4	42
6	Field Firing	4	36	8	Field Fire (Single and Multiple Targets)	4	36
				9	Rezeroing and Timed Fire (25 M Silhouette)	4	32
7	Practice Record Fire	4	40	10	Combat Firing (Record Fire Range)	4	50
8	Record Fire	5	40	11	Record Fire	4	40
9	Twenty-Five Meter Automatic Firing	3	45	12	Automatic Firing	2	21
				13	Protective Mask Firing	2	20
10	Night Record Firing	3	89	14	Night Firing	3	30
	Totals	37	334		Totals	57	349

Duration of Training Time

Conventional wisdom across the years has regarded a 90 hour marksmanship training program as about right for acquiring entry level skill. This has permitted sufficient repetition of fundamental skills for original learning and acceptable skill retention. In recent attempts to conserve time and ammunition the Army has drastically reduced program length. The new program reverses this trend, increasing from 37 to 57 hours, but still far short of the 90 hours of the past. Much of this newly revised training is still episodic, meaning the student performs an exercise one time and then moves on to something else. For example, the downrange feedback exercise from the new program is done once not because that is sufficient but rather because there is not time to repeat it. Again, this problem area will require high level policy decisions to effect change. In all probability an examination of the entire basic training program length would be involved.

Shooting Performance Feedback

Whether or not the training program length is adequate is partly a matter of how efficiently the time can be utilized. One major effort in developing the new program has been to make each period of instruction as self teaching as possible so that the student, even in the absence of instructors, can acquire the intended skill. Very important in this process is shooting performance skill. Many of the new exercises have much more adequate feedback built in, particularly the 25 meter activities (i.e., ARI zeroing target, silhouette exercises).

There are two new equipment developments that hold great promise for improved skill acquisition because they greatly aid in providing feedback about shooting performance. One device is WEAPONEER, a training aid that is already in use (see Figure 9). WEAPONEER simulates the M16A1 rifle in feel, noise, recoil and trajectory. As currently used in the new marksmanship training program, soldiers demonstrating difficulty are brought in to "fire" shot groups on a WEAPONEER. The device provides shot by shot feedback of hit or miss location and it even includes a video playback trace of the firer's actual point of aim during the three seconds just prior to trigger pull. It is thus an excellent diagnostic and corrective device that can be used day or night back in garrison or near a live fire range.

A live fire target device that suggests great promise for providing downrange feedback is SUPER DART, a newly patented "projectile location system" (see Figure 10). SUPER DART detects any supersonic projectile passing the plane of the target (whether hit or miss) and provides precise locational feedback to the firer by means of a video display unit. Used in conjunction with a popup target the firer could be given detailed

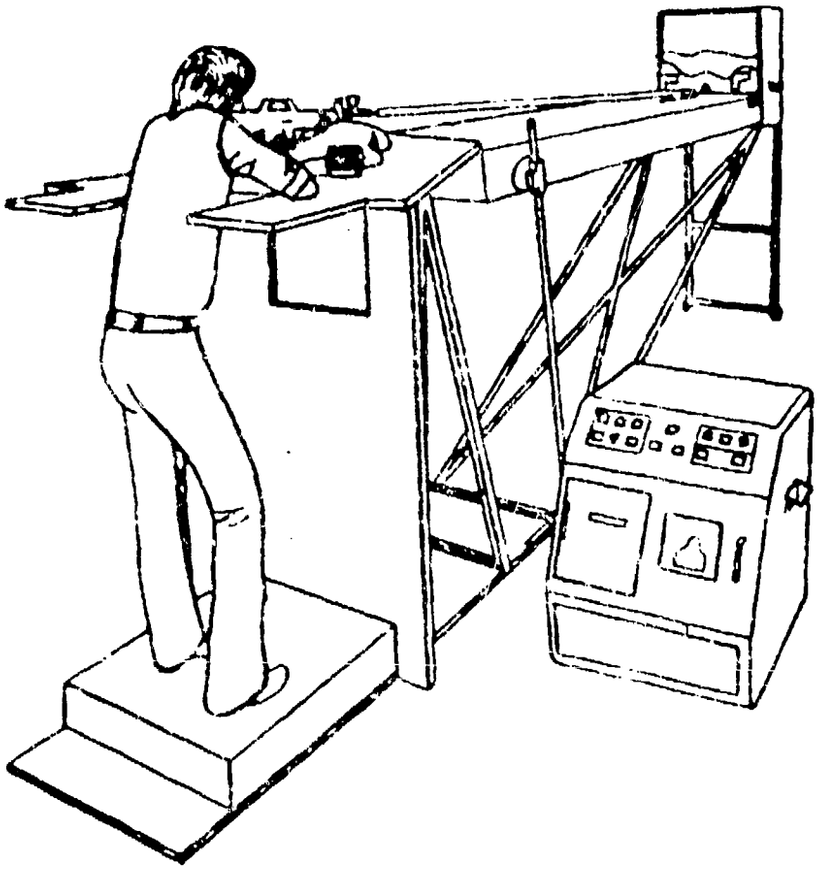


Figure 9. The WEAPONEER, an indoor M16A1 rifle training device that simulates sound, recoil and trajectory characteristics. It is used in the new program for diagnosis and remediation of problem shooters.

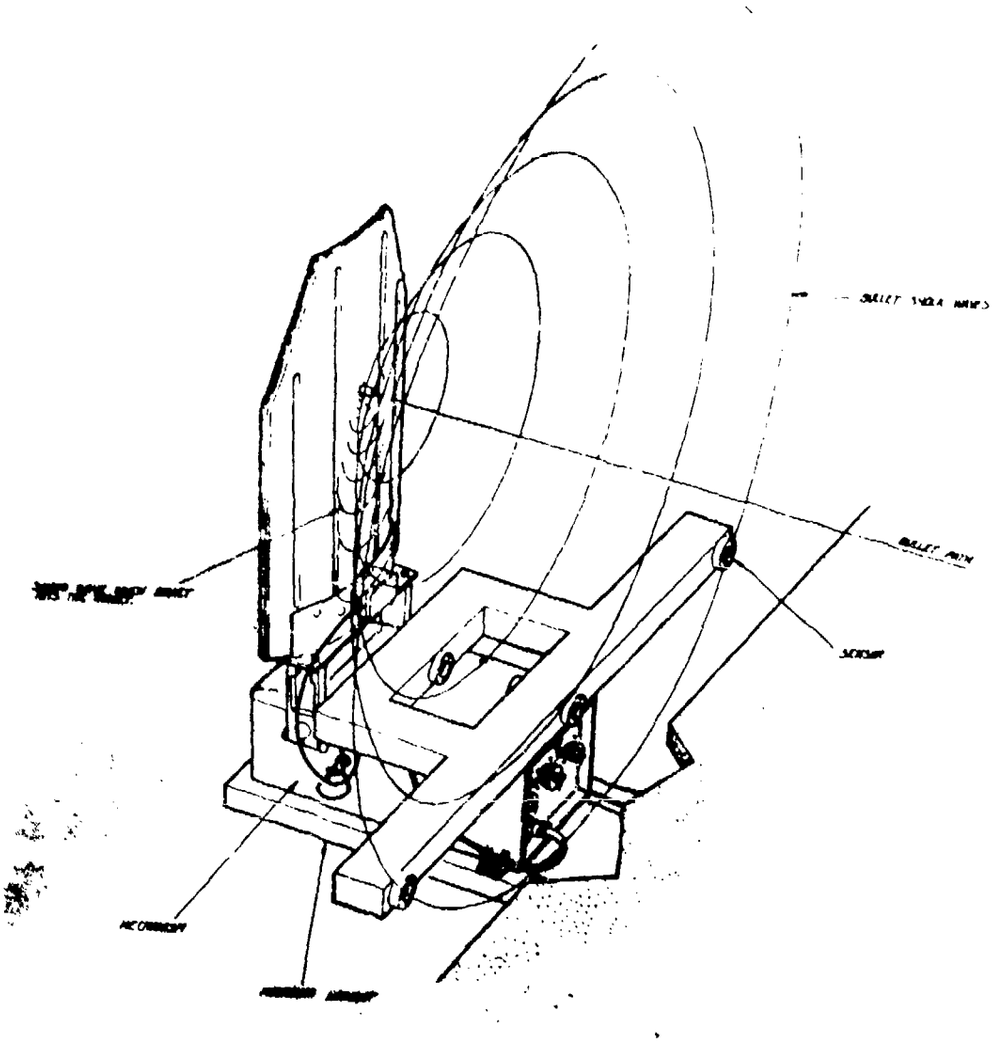


Figure 10. The SUPER DART projectile location system. The detector bar senses the shock wave of the passing bullet and accurately plots the position on a video display unit, whether the bullet hits or misses the target.

information about location of any misses but also about exact position of hits. The beginner could correct errors though he was "missing the target" even by several feet. The more accomplished shooter could sharply refine his target hit performance because the manufacturer claims resolution capability for the device of one millimeter or less near the center of a target.

What real promise this technology has for improved instruction can only be speculated at this writing but it could possibly save considerably in both hours and ammunition compared to the current field fire training equipment which provides such limited and imprecise feedback that skill acquisition is slow and incomplete.

SUPER DART needs to be tested to see if it is a cost and training effective way to improve marksmanship. What is currently clear is that simple hit vs. miss feedback provided by field fire targets such as the M31A1 mechanisms used in the current TRAINFIRE program or the Infantry Remoted Target System (IRETS, the system being tested as a replacement for TRAINFIRE) is inadequate. As long as marksmanship training equipment replacements are being considered, SUPER DART or similar systems would appear to be among the most promising candidates for live fire training. They could result in considerable increments in field fire skill over what is now possible. For the difficult area of training shooters to engage moving targets the projectile location system has even greater promise.

NEXT STEPS IN ARI MARKSMANSHIP RESEARCH

With the adoption of the new entry level marksmanship training program the ARI and Litton Mellonics research team has now turned attention to the study of advanced individual and unit level marksmanship. The overall goal of this effort is to achieve an integrated set of programs that train from basic to advanced skills, from individual to group tasks and from skill acquisition to long term skill retention. The intent is to identify, prioritize and then give training on all priority individual and team skills a rifleman needs in order to meet the various categories of threat that could be expected in future confrontations.

Among the tasks likely to receive high priority attention in this research are:

- Techniques of engagement of moving targets (an area greatly enhanced by the new technologies for locating misses as well as hits, e.g., SUPER DART and WEAPONEER);

- Use of the rifle in a nuclear, biological and chemical (NBC) environment;

- Techniques of night firing;

- Utilization of the automatic mode of fire and techniques for its use when appropriate;

- Offensive vs. defensive firing (e.g., assault firing techniques, other firing positions);

- Use of the rifle in military operations in urban terrain (MOUT);

- Squad techniques of fire (e.g., fire control and distribution).

At the beginning of this research project the purpose was to develop cost and training effective alternatives to the then standard training program. Because of the serious training and final performance deficiencies discovered, the goal now is to try to make the corrections and policy changes necessary to return the American rifleman to his former stature as the finest in the world.

REFERENCES

Dees, J. W., Magner, G. J., & McCluskey, M. R. An experimental review of basic combat rifle marksmanship: MARKSMAN, Phase I. HumRRO, Technical Report 71-4, March 1971.

Evans, K. L., Thompson, T. J., & Smith, S. FORSCOM/U.S. Army Marksmanship Unit M16A1 rifle and .45 cal. pistol marksmanship training evaluation. U.S. Army Research Institute, Research Report 1263, August 1980.

Hicks, J. A., III & Tierney, T. J., Jr. Cadre evaluations of the rifle laser and rimfire adapter rifle marksmanship training devices. U.S. Army Research Institute, Research Report 1196, August 1978.

Klein, R. D. & Tierney, T. J., Jr. Analysis of factors affecting the development of threat oriented small arms training facilities. U.S. Army Research Institute, Technical Report 78-B2, February 1978.

Maxey, J. L. & Dempster, J. R., Jr. Survey of M16A1 basic rifle marksmanship - current procedures and practices. Litton-Mellonics, Task Report, August 1978.

Maxey, J. L. & George, J. D. Analysis of current training, Task A-3, Part one: M16A1 rifle, Analysis of M16A1 basic rifle marksmanship training. Litton-Mellonics, Task Report, December 1977.

Maxey, J. L. & Sweezy, R. W. Training effectiveness analysis research, Task A-6, Instructional approaches for individualizing basic rifle marksmanship training. Litton-Mellonics, Task Report, December 1977.

McFann, H. H., Hammes, J. A., & Taylor, J. E. TRAINFIRE I: A new course in basic rifle marksmanship. HumRRO, Technical Report 22 October 1955.

Olmstead, I. A. & Jacobs, T. O. The effects of changes in transition firing upon "quick kill" proficiency. Technical Report 69-14, Human Resources Research Office, July 1969.

Osborne, A. D., Morey, J. C., & Smith, S. Adequacy of M16A1 rifle performance and its implications for marksmanship training. U.S. Army Research Institute, Research Report 1265, September 1980.

Smillie, R. J. & Chitwood, T. E., Jr. Training effectiveness analysis research, Task A-1, Literature Review, Army training: M16A1 Rifle, TOW and Dragon weapon systems. U.S. Army Research Institute, Research Report 1254, August 1980.

Smith, S., Thompson, T. J., Evans, K. L., Osborne, A. D., Maxey, J. L., & Morey, J. C. Effects of down-range feedback and the ARI zeroing target in rifle marksmanship training. U.S. Army Research Institute, Research Report 1251, June 1980.

Staff, HumRRO. Trainfire V: Extension of research on Trainfire I rifle marksmanship course. Research memorandum, Human Resources Research Office, November 1959.

Thompson, T. J., Smith, S., Morey, J. C., & Osborne, A. D. Effectiveness of improved basic rifle marksmanship training programs. U.S. Army Research Institute, Research Report 1255, September 1980.

Tierney, T. J., Jr. & Cartner J. A. Basic rifle marksmanship test: Cadre pretest and posttest attitudes. U.S. Army Research Institute Research Problem Review 78-7, August 1978.

Tierney, T. J., Jr., Cartner, J. A., & Thompson, T. J. Basic rifle marksmanship test: Trainee pretest and posttest attitudes. U.S. Army Research Institute, Technical Paper 354, August 1977.

TRASANA. Basic rifle marksmanship cost and training effectiveness analysis. Technical Report 16-77 (Volume I - Executive Summary), September 1977.

TRASANA. Basic rifle marksmanship cost and training effectiveness analysis. Technical Report 16-77 (Volume II - Main Report), September 1977.

U.S. Army Infantry School (Directorate of Training Developments) M16A1 rifle marksmanship training program of instruction. April 1977.

USAIS, Basic rifle marksmanship instructor's guide. Coordinating Draft, U.S. Army Infantry School (prepared by Litton Mellonics/Army Research Institute), January 1980.

USAIS, M16A1 rifle marksmanship training Draft Program of Instruction (Prepared originally by Litton-Mellonics/Army Research Institute), U.S. Army Infantry School, Fort Benning, Georiga, June 1980.

U.S. Department of the Army. Army Subject Schedule no. 23-72: M16A1 rifle marksmanship. Washington, 15 March 1974.

DISTRIBUTION

1 US ARMY WESTERN COMMAND ATTN: APPE
1 DEPARTMENT OF THE NAVY TRAINING ANALYSIS AND EVALUATION GROUP
1 HQDA ATTN: DAAG-ED
1 US PACIFIC FLEET HUMAN RESOURCE MANAGEMENT DETACHMENT
1 HQ, TCATA ATTN: ATCAT-OP-Q
2 HQDA RESEARCH AND STUDIES OFC
1 MILITARY OCCUPATIONAL DEVELOPMENT DIV DAPC-MSP-O, RM 852C HOFFMAN BLDG 1
4 OASD (MRA AND L)
1 HQ TCATA TECHNICAL LIBRARY
1 HQDA ODCSPER
1 HQDA ATTN: DAMI-ISI
1 USA AVIATION SYSTEMS COMD ATTN: DRSAV-ZDR
1 USA CORADCOM ATTN: AMSEL-PA-RH
1 HEADQUARTERS US MARINE CORPS ATTN: CODE MTMT
1 HEADQUARTERS, US MARINE CORPS ATTN: CODE MPI-20
2 US ARMY EUROPE AND SEVENTH ARMY
1 1ST INFANTRY DIVISION AND FT. RILEY ATTN: AFZN-DPT-T
1 CHIEF, ATTITUDE & OPINION SURVEY DIVISION ATTN: ATZI-NCR-MA, HOFFMAN BLDG II
1 USA INTELLIGENCE AND SECURITY COMMAND ATTN: IAOPS-TNG-T
2 HQ TRADOC TECHNICAL LIBRARY
1 NAVAL TRAINING EQUIPMENT CEN ATTN: TECHNICAL LIBRARY
1 MILITARY OCCUPATIONAL DEVELOPMENT DIRECTORATE ATTN: ATZI-NCR-MS-M, RM 3N33 HOFFMAN BLDG II
1 DATA ANALYSIS DIVISION ATTN: ATZI-NCR-MD, HOFFMAN BLDG II
1 USA MILPERCEN ATTN: DAPC-POO-T
1 8TH INFANTRY DIVISION
1 HQDA ARMY FORCE MODERNIZATION COORDINATION OFFICE
1 HQDA ATTN: DASG-PTB
1 123D USARCOM RESERVE CENTER
1 US ARMY SOLDIER SUPPORT CENTER /
1 USA FORCES COMMAND AFLG - DEPUTY CHIEF OF STAFF FOR LOGISTICS
1 US ARMY AIR DEFENSE SCHOOL ATTN: ATSA-DTD
1 DIRECTORATE OF TRAINING ATTN: ATZQ-T
1 DIRECTORATE OF COMBAT DEVELOPMENTS ATTN: ATZQ-D
1 HQDARCOM MARINE CORPS LIAISON OFC
1 DEPARTMENT OF THE ARMY US ARMY INTELLIGENCE & SECURITY COMMAND
1 USA MISSILE COMMAND ATTN: DRSMI-NTN
1 US ARMY CECOM ATTN: DRSEL-ATDD
1 USA FORCES COMMAND
1 PM TRADE /
1 US MILITARY DISTRICT OF WASHINGTON OFC OF EQUAL OPPORTUNITY
1 NAVAL CIVILIAN PERSONNEL COMD SOUTHERN FLD DIV
22 ARI LIAISON OFFICE
1 7TH ARMY TRAINING COMMAND
1 ARMY TRAINING SUPPORT CENTER INDIVIDUAL TRAINING EVALUATION
1 HQDA, DCSOPS INDIVIDUAL TRAINING
1 HQDA, DCSOPS TRAINING DIRECTORATE
1 HQDA, DCSLOG MAINTENANCE MANAGEMENT
1 HQDA, OCS STUDY OFFICE
1 U.S. NAVY TRAINING ANALYSIS EVALUATION GROUP
1 USACDEC ATTN: ATEC-EX-E HUMAN FACTORS
1 ATTN: SM-ALC/DPCR
1 USAFAGOS/TAC SENIOR ARMY ADVISOR
1 OASA (RDA) DEPUTY FOR SCIENCE AND TECHNOLOGY
1 OFC OF NAVAL RESEARCH /
1 AFHRL/LRT
1 AFHRL/LRLG
1 AIR FORCE HUMAN RESOURCES LAB ATTN: AFHRL/TSR
1 AFAMRL/BB
1 NAVY PERSONNEL R AND D CENTER DIRECTOR OF PROGRAMS
1 NAVY PERSONNEL R AND D CENTER /
2 OFC OF NAVAL RESEARCH PERSONNEL AND TRAINING RESEARCH PROGRAMS

1 NAVAL PERSONNEL R + D CENTER /
1 OFC OF NAVAL RESEARCH PROJECT OFFICER, ENVIRONMENTAL PHYSIOLOGY
1 NAVAL AEROSPACE MEDICAL RSCH LAB AIRBORNE RANGER RESEARCH
1 NAVAL AEROSPACE MEDICAL RSCH LAB AEROSPACE PSYCHOLOGY DEPARTMENT
1 USA TRADOC SYSTEMS ANALYSIS ACTIVITY ATTN: ATAA-TCA
1 HEADQUARTERS, COAST GUARD CHIEF, PSYCHOLOGICAL RSCH BR
1 USA RESEARCH AND TECHNOLOGY LAB /
1 USA MOBILITY EQUIPMENT R AND D COMD ATTN: DRDME-TQ (SCHOOL)
1 FT. BELVOIR, VA 22060
1 ATTN: ATTG-ATB-TA
1 USA MATERIEL SYSTEMS ANALYSIS ACTIVITY ATTN: DRXSY-C
1 NAFEC HUMAN ENGINEERING BRANCH
1 USA ARCTIC TEST CEN ATTN: AMSTE-PL-TS
1 USA COLD REGIONS TEST CEN ATTN: STECR-OP
1 USA ELECTRONIC WARFARE LAB CHIEF, INTELLIGENCE MATER DEVEL + SUPP OFF
1 USA RSCH DEVEL + STANDARDIZA GP, U.K.
1 USA RESEARCH AND DEVELOPMENT LABS CHIEF, BEHAV SCIENCES DIV, FOOD SCI LAB
1 NAVAL AIR SYSTEMS COMMAND ATTN: AIR-5313
1 USACDEC TECHNICAL INFORMATION CENTER
1 USAARL LIBRARY
1 USA TRADOC SYSTEMS ANALYSIS ACTIVITY ATTN: ATAA-SL (TECH LIBRARY)
1 UNIFORMED SERVICES UNIT OF THE HEALTH SCI DEPARTMENT OF PSYCHIATRY
1 GRONINGER LIBRARY ATTN: ATZF-RS-L BLDG 1313
1 CENTER FOR NAVAL ANALYSIS
1 NAVAL HEALTH RSCH CEN LIBRARY
1 NAVAL PERSONNEL R AND D CEN LIBRARY ATTN: CODE P106
1 AIR FORCE HUMAN RESOURCES LAB ATTN: AFHRL/OTS
1 HQ, FT. HUACHUCA ATTN: TECH REF DIV
1 USA ACADEMY OF HEALTH SCIENCES STIMSON LIBRARY (DOCUMENTS)
1 SCHOOL OF SYSTEMS AND LOGISTICS /
1 DEPARTMENT OF THE NAVY TRAINING ANALYSIS AND EVALUATION GP
1 USMA DEPT OF BEHAVIORAL SCI AND LEADERSHIP
1 USA COMMAND AND GENERAL STAFF COLLEGE ATTN: LIBRARY
1 USA TRANSPORTATION SCHOOL USA TRANSP TECH INFO AND RSCH CEN
1 USA ADMINCEN TECHNICAL RESEARCH BRANCH LIBRARY
1 USA FIELD ARTY BD /
1 INSTITUTE FOR DEFENSE ANALYSES
1 USA TRAINING SUPPORT CENTER ATTN: ATIC-DST-PA
1 AFHRL TECHNOLOGY DFC (H)
1 USA MOBILITY EQUIPMENT R AND D COMMAND ATTN: DRDME-ZG
1 DA US ARMY RETRAINING BDE RESEARCH + EVALUATION DIVISION
1 HUMAN RESOURCE MANAGEMENT CEN, SAN DIEGO
1 USAFA DEPT OF BEH SCI + LEADERSHIP
1 US MILITARY ACADEMY DEPT. OF HISTORY, BLDG 601
1 USA INTELLIGENCE CEN AND SCH ATTN: SCHOOL LIBRARY
1 USA INTELLIGENCE CEN AND SCH ATTN: ATSI-DP
1 MARINE CORPS INSTITUTE
1 NAVAL SAFETY CENTER /
1 US COAST GUARD TNG CEN ATTN: EDUCATIONAL SVCS OFFICER
1 GALLAUDET COLLEGE LEARNING CENTER
1 USAAVNC AND FT. RUCKER ATTN: ATZQ-ES
1 US ARMY AVN TNG LIBRARY ATTN: CHIEF LIBRARIAN
1 USA AIR DEFENSE SCHOOL ATTN: ATSA-DT
1 USAAVNC ATTN: ATZQ-D
1 US MILITARY ACADEMY DIRECTOR OF INSTITUTIONAL RSCH
1 USAADS-LIBRARY-DOCUMENTS
1 USA SERGEANTS MAJOR ACADEMY ATTN: LEARNING RESOURCES CENTER
1 USA INFANTRY BOARD ATTN: ATZB-IB-AE
1 USA INTELLIGENCE CEN AND SCH ATTN: ATSI-DT-SFL
1 USA ORDNANCE CEN AND SCH ATTN: ATSL-TD-TAC
1 USA ARMOR SCHOOL ATTN: ATZK-TD
1 USA ARMOR CENTER DIRECTORATE OF COMBAT DEVELOPMENTS

1 NAVAL POSTGRADUATE SCH ATTN: DUDLEY KNOX LIBRARY (CODE 1424)
1 USA TRANSPORTATION SCHOOL DEPUTY ASST. COMMANDANT EDUCA. TECHNOLOGY
1 USA SIGNAL SCHOOL AND FT. GORDON ATTN: ATZH-ET
1 USA QUARTERMASTER SCH ATTN: ATSM-TNG-TM-ET
1 USA MILITARY POLICE SCHOOL ATTN: LIBRARY
1 USA ARMOR CENTER + FT. KNOX OFFICE OF ARMOR FORCE MGT + STANDARDIZATION
1 CHIEF OF NAVAL EDUCATION AND TNG /
1 USA SIGNAL SCHOOL + FT. GORDON EDUCATIONAL TECHNOLOGY DIVISION
1 HQ AIC/XPTD TRAINING SYSTEMS DEVELOPMENT
1 USA INSTITUTE FOR MILITARY ASSISTANCE ATTN: ATSU-TD-TA
1 US ARMY ARMOR CENTER ATTN: ATZK-TD-PMO
1 USA AIR DEFENSE CENTER, FT. BLISS ATTN: ATZC-DIM
1 USA QUARTERMASTER SCHOOL DIRECTORATE OF TRAINING DEVELOPMENTS
1 US COAST GUARD ACADEMY /
1 USA TRANSPORTATION SCHOOL DIRECTORATE OF TRAINING + DOCTRINE
1 USA INFANTRY SCHOOL LIBRARY /
1 USA INFANTRY SCHOOL ATTN: ATSH-I-V
1 US ARMY INFANTRY SCHOOL ATTN: ATSH-CD
1 USA INFANTRY SCHOOL ATTN: ATSH-DOT-LRD
1 USA INFANTRY SCHOOL ATTN: ATSH-EV
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN ATTN: ATZN-PTS
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN DIR. COMBAT DEVELOPMENT
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN DIR. TRAINING DEVELOPMENT
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN ATTN: ATZN-MP-ACE
1 USA INSTITUTE OF ADMINISTRATION ATTN: RESIDENT TRAINING MANAGEMENT
1 USA FIELD ARTILLERY SCHOOL MORRIS SWETT LIBRARY
1 USA INSTITUTE OF ADMINISTRATION ACADEMIC LIBRARY
1 USA WAR COLLEGE ATTN: LIBRARY
1 USA ENGINEER SCHOOL LIBRARY AND LEARNING RESOURCES CENTER
1 USA ARMOR SCHOOL (USARMS) ATTN: LIBRARY
1 US COAST GUARD ACADEMY LIBRARY
1 USA TRANSPORTATION SCHOOL TRANSPORTATION SCHOOL LIBRARY
1 ORGANIZATIONAL EFFECTIVENESS CEN + SCH ATTN: LIBRARIAN
1 US ARMY INTELLIGENCE CENTER + SCHOOL ATTN: ATSI-TP
1 US ARMY INTELLIGENCE CENTER + SCHOOL ATTN: ATSI-RM-M
1 US ARMY INTELLIGENCE CENTER + SCHOOL ATTN: ATSI-ES
1 US MARINE CORPS EDUCATION CENTER
1 USA FIELD ARTILLERY SCHOOL DIRECTORATE OF COURSE DEV + TRAINING
1 DEPARTMENT OF THE AIR FORCE AIR UNIVERSITY LIBRARY (ATC)
1 USA CHAPLAIN CENTER + SCHOOL ATTN: ATSC-TD-OD
1 USA CHAPLAIN CENTER + SCHOOL ATTN: ATSC-TD-ED
1 USA CHAPLAIN CENTER + SCHOOL ATTN: ATSC-TD-SF
1 USA CHAPLAIN CENTER + SCHOOL ATTN: ATSC-DOS-LLC
1 HQ TRADOC TRAINING DEVELOPMENT INSTITUTE
2 BRITISH EMBASSY BRITISH DEFENCE STAFF
2 CANADIAN JOINT STAFF
1 COLS (W) LIBRARY
1 FRENCH ARMY ATTACHE
1 AUSTRIAN EMBASSY DEFENSE, MILITARY AND AIR ATTACHE
3 CANADIAN DEFENCE LIAISON STAFF ATTN: COUNSELLOR, DEFENCE R AND D
1 ROYAL NETHERLANDS EMBASSY MILITARY ATTACHE
1 CANADIAN FORCES BASE CORNWALLIS ATTN: PERSONNEL SELECTION
2 CANADIAN FORCES PERSONNEL APPL RSCH UNIT
1 ARMY PERSONNEL RESEARCH ESTABLISHMENT
6 LIBRARY OF CONGRESS EXCHANGE AND GIFT DIV
1 DEFENSE TECHNICAL INFORMATION CEN ATTN: DTIC-DDA-2
140 LIBRARY OF CONGRESS UNIT DOCUMENTS EXPEDITING PROJECT
1 US GOVERNMENT PRINTING OFC LIBRARY, PUBLIC DOCUMENTS DEPARTMENT
1 US GOVERNMENT PRINTING OFC LIBRARY AND STATUTORY, LIB DIV (SLL)
1 THE ARMY LIBRARY ATTN: ARMY STUDIES SEC
3 / /
1 / /